

THE BIOLOGY OF *APIOCERA HARUSPEX* OSTEN SACKEN (DIPTERA: APIOCERIDAE) IN CENTRAL CALIFORNIA, AND COMPARISON WITH OTHER ASILOIDEA

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Relatively little has been published on the biology of the Apioceridae.¹ The most complete study is that by Cazier (1963) on the bionomics of *Apiocera painteri* Cazier. Lavigne (1975) noted similarities between *A. painteri* and *A. clavator* Painter while discussing the general behavior of the latter. English (1947) and Irwin and Stuckenberg (1972) emphasized larval morphology in their works on Southern Hemisphere species; while Norris (1936) and Paramonov (1953) briefly reported on oviposition and adult feeding respectively. Observations on *Apiocera haruspex* Osten Sacken are recorded here for comparison, both with other apiocerids and with related members of the Asiloidea.

Materials and Methods

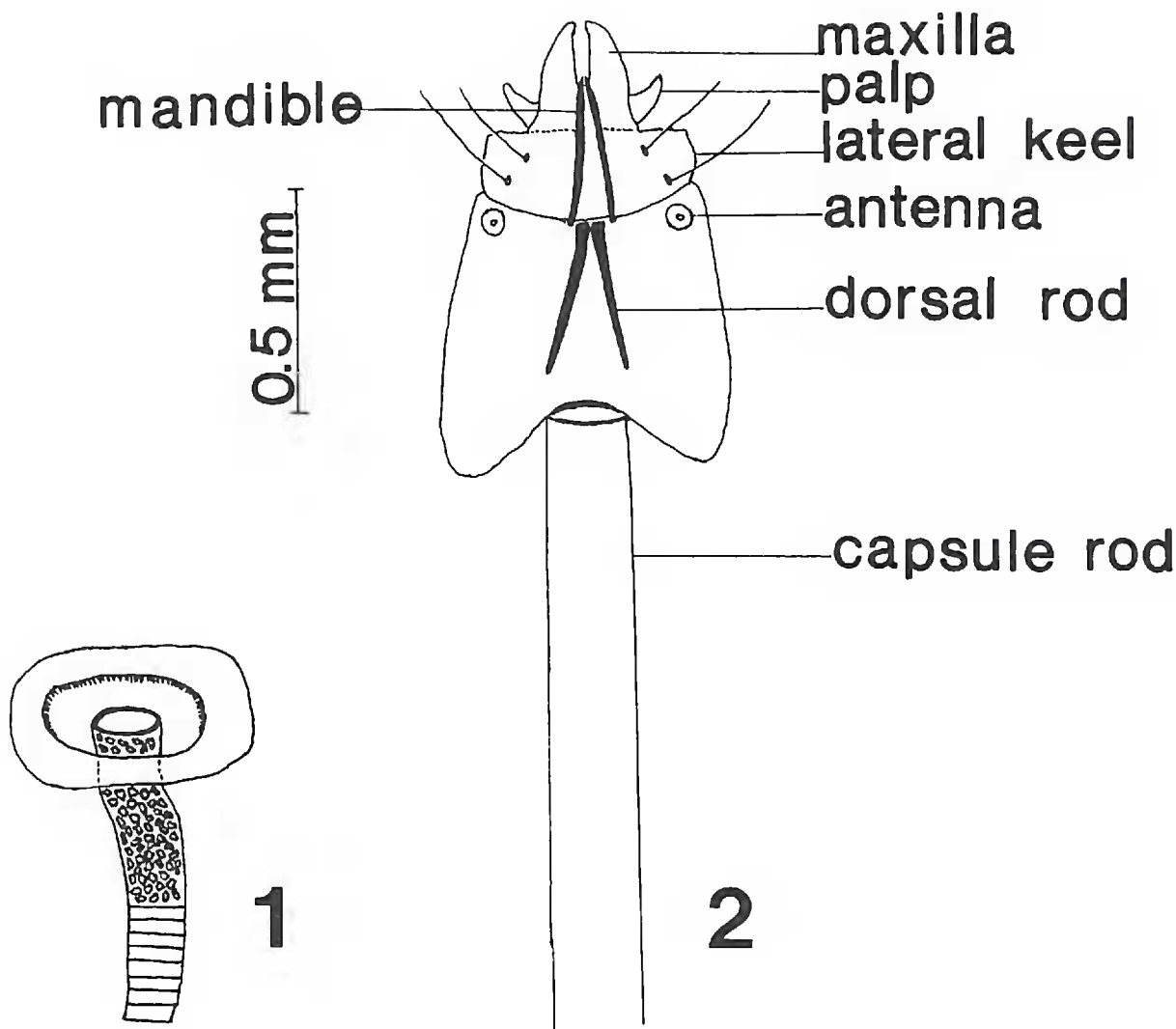
A population of *A. haruspex* was first observed along the sandy banks of the middle fork of the Cosumnes River in August 1976. The site is approximately 5 km southwest of Somerset, El Dorado County, California at an elevation of 650 m. Subsequent observations were made in August and September of 1977 and 1978 along the river and on grassy hillsides above the river canyon. Observations on asilids were made in the same area. Voucher specimens on which observations were made are deposited in the collections of Mont Cazier and the author.

One *A. haruspex* egg clutch was excavated immediately following oviposition, and the eggs kept with sand in a glass jar. The single hatched larva is that on which the following description is based.

Results

Larva.—The single larva attained a length of 5.5 mm in 2 months before it died, and moulted only once. Because it was not preserved immediately after death, some details are difficult to discern. The larva of *A. haruspex* is very similar to that of *A. maritima* Hardy (English, 1947) and completely different from that of *Tongamyia miranda* Stuckenberg (Irwin and Stuckenberg, 1972).

All segments subequal in length except terminal segment noticeably shorter. Intersegmental constrictions of abdomen similar to those of *A. maritima*



Figs. 1, 2. *Apiocera haruspex*. Fig. 1. Posterior spiracle and terminal portion of tracheal trunk in penultimate abdominal segment, second instar larva. Fig. 2. Dorsal view of head capsule of same larva.

(English, 1947: Fig. 1) most evident on abdominal segments 1–5. Apical segment broadly rounded as in *A. maritima* and *A. painteri*, and bearing at least one pair of long, subapical setae. Posterior spiracle opening on penultimate segment, funnel-shaped, with single opening (Fig. 1). Head (Fig. 2) very similar to *A. maritima*, consisting of well-developed anterior and posterior portions. Posterior portion dorsally with rounded antennal discs anterolaterad, each disc bearing a raised tubercle; pair of median dorsal rods extending further posteriorly than in *A. maritima*; posterolateral lobes and capsule rod present and similar in shape to those of *A. maritima*; posterior portion with 2 pairs of stout setae ventrolaterad. Anterior portion arched dorsally; mandibles, maxillae, and maxillary palps as in *A. maritima*, prominent; lateral keel and setae less well-developed.

Phenology.—*A. haruspex* adults were found only during August 1976 and 1978, and September 1977. Adult activity was restricted to a 2–3 week period in each population, with slight variation among populations and years. The

Table 1. Foray behavior by *Apiocera haruspex* males (6 individuals).

	Individuals						Totals
	1	2	3	4	5	6	
Interspecific encounters	2	1	4	7	5	2	21
Intraspecific encounters							
with other males	0	5	1	1	1	7	15
No other animals visible	6	21	11	8	17	8	71

ratio of females to males became greater as the season advanced, as was noted for *A. painteri* by Cazier (1963). Males and females were active throughout the day, generally initiating activity between 0900 and 1000 PDT. Individuals sitting in sunny positions usually became active before those in shaded positions, suggesting that ambient temperatures influence initiation of activity (see also Lavigne, 1975).

Mating.—Mating behavior in *A. haruspex* is similar to that described by Cazier (1963) and Lavigne (1975) for other *Apiocera* species. Four pairs of *A. haruspex* were observed *in copulo*, all between 1130 and 1715 PDT. Initiation of coupling was not seen; and when first observed, all couples were on the ground. Pairs remained *in copulo* up to 23 min in a tail-to-tail position. As in *A. painteri*, the flies became active following an initial stationary period. While still *in copulo* they rotated in a clockwise and/or counter-clockwise direction and flew short distances. Final separation occurred after several jerks of the male abdomen. During copulation, males were more active than females.

Male behavior.—As noted by Cole (1969:179), *A. haruspex* closely resembles asilids of the genus *Efferia*. In addition to similarity in shape and color pattern, males are behavioral mimics as well. Males occupy sunny perches (e.g., twigs, grass stems), or sit in a clearing, and make forays identical to prey-capture flights of a sympatric *Efferia* sp. In 66% of the *A. haruspex* forays, no other insects were in the vicinity (Table 1). While such forays may serve for visual orientation, this species also flew at other insects passing nearby. Both inter- and intraspecific encounters were observed, but never any case of predation. Species of the genus *Apiocera* are, in fact, not predaceous (Paramonov, 1953; Lavigne, 1975), and have only sponging-type mouth parts.

Oviposition and fecundity.—The oviposition behavior of six females was recorded. The following sequence was noted: female stood with body at steep angle to substrate; abdomen pushed from side to side into substrate; complete burial of abdomen and part of thorax accomplished in 5–10 sec; female remained buried for 1.5–2.0 min; abdomen pulled out of soil in 5–10 sec;

tip of abdomen usually wriggled briefly over surface; fly moved quickly to one side and quickly kicked sand over the oviposition site with hind legs; female moved to new oviposition site. Total oviposition time was between 2 and 3 min. Similar to findings of Cazier (1963) with other *Apiocera* species, females oviposit in sandy soils in shaded situations, most often in leaf litter or near the base of small bushes. False starts were commonly noted, with females inserting only the apical 1–3 segments into the substrate before withdrawing without ovipositing. Cazier (1963) suggested that failure to oviposit in such cases was most probably due to the fly encountering an obstacle or harder subsurface soils before the abdomen was fully distended. All observations on oviposition were made in the afternoon.

One cluster of five eggs was uncovered in the field. Two adult females were dissected, one of which had eight follicles per ovariole and contained 200 eggs in various stages of development. The second female had only 16 very large eggs filling the abdominal cavity.

Discussion

Available information suggests that larvae of *Apiocera* species are very similar to each other. Major features are the shape of the posterior spiracles, head, and caudal segment; presence of a lateral keel, dorsal rod, and capsule rod; shape and placement of mandibles, maxilla, and maxillary palp. All of the above features differ in the first instar larva of *Tongamyia miranda* (Irwin and Stuckenberg, 1972). Although such lack of agreement between genera may merely reflect differences among instars, the magnitude of the dissimilarities suggests that the various character states may be representative of distinct phylogenetic lines. It will thus be of interest to discover if other members of the Megascelinae have larvae similar to that of *Tongamyia*; and if *Rhaphiomydas* has larvae similar to *Apiocera*.

Combining the observations on *A. haruspex* with those of Cazier (1963) on *A. painteri* and Lavigne (1975) on *A. clavator*, mating in *Apiocera* consists of an initial pairing, followed by a stationary period in a tail-to-tail position, and finally an active uncoupling period which may include short flights. Similar behavior has been reported for some asilid species (Lavigne and Holland, 1969; Dennis and Lavigne, 1975). Known mydid species, however, mate in a male over female position (Wharton, 1981).

Male forays probably serve a dual purpose. They may function in behavioral mimicry of their aggressive asilid models and they may also serve to increase intraspecific encounters, which may be important for initial meeting of the sexes. Toft and Kimsey (personal communication) are working on the role of forays and other behavioral traits in aggregation behavior. Establishment of temporary territories in conjunction with forays was also noted for the asilid *Proctacanthella leucopogon* (Williston) by Lavigne and Dennis (1980), and for *Mydas* by Wilcox and Papavero (1971).

Oviposition in sandy substrates is noticeably similar in some asilids (Meilin, 1923), mydids (Hesse, 1974; Wilcox and Papavero, 1971; Wharton, 1981), apiocerids, and the *Thereva*-group in therevids (Irwin, 1976). In these groups, species that oviposit in sandy soils possess acanthophorites. Many other therevids also possess acanthophorites, but their oviposition behavior is more complex (Irwin, 1976). The long, telescopic abdomen and burial of abdomen (and often part of the thorax) allow for deep penetration and egg deposition away from surface predators and parasitoids; and in hot, arid regions, where most such species occur, provide a cooler environment for developing eggs.

Acanthophorites serve in initial excavation (Meilin, 1923), in creating a temporary oviposition chamber by rapid twirling immediately prior to egg deposition (Cazier, 1963; personal observation), and in scraping the oviposition site afterwards (Lavigne and Holland, 1969; Dennis and Lavigne, 1975). Placement of the stout, modified setae on the acanthophorite reflects their use in oviposition. In *A. haruspex*, setae occur in lateral rows, one row on each side. As the abdomen is inserted into the soil during oviposition, it is moved from side to side—for maximum efficiency in use of the setae as excavators. In *Proctacanthus*, an asilid, setae are concentrated in a cluster posteriorly. As the abdomen is inserted into the soil, it is moved back and forth rather than from side to side—again for maximum efficiency during excavation.

Irwin (1976) discussed plesiomorphic and apomorphic states for the acanthophorite. The laterally placed rows of thickened setae, while undoubtedly an apomorphic state, are nevertheless found throughout the Asiloidea. This condition is thus a relatively stable one, and indicative of common ancestry.

Similarities in the oviposition behavior of apiocerids, certain mydids, and some asilids suggest that such characteristics are of a plesiomorphic nature. This supports the findings of Irwin (1976) that similar behavior in the *Thereva*-group is the plesiomorphic state within the Therevidae.

Clutch size and duration of oviposition are similar in *Apiocera*, several mydids (Wharton, 1981), and asilids which oviposit in the soil (Dennis and Lavigne, 1975). Clutch size is considerably larger in *Tongamyia*, however (Irwin and Stuckenberg, 1972). The striking differences between *Tongamyia* and *Apiocera*, both biologically and morphologically, further suggest that the two should be regarded as only distantly related.

Acknowledgments

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Footnote

¹ The observations of Toft and Kimsey (1982, *J. Kans. Entomol. Soc.*, 55:177–186) were published while this paper was in press and are not incorporated herein.